FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE TRANSMITTAL LETTER TO THE UNITED STATES DESIGNED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NO. PHN 17,285 U.S. Application No. (if known, see 37 CFR 1.5) 09/623945
INTERNATIONAL APPLICATION NO. PCT/EP00/00217	INTERNATIONAL FILING DATE 10 January 2000	PRIORITY DATE CLAIMED 10 January 1999

TITLE OF INVENTION
EMBEDDING SUPPLEMENTAL DATA IN AN ENCODED SIGNAL

APPLICANT(S) FOR DO/EO/US
FRANCISCUS L.A.J. KAMPERMAN, ALPHONS A.M.L. BRUEKERS, RENATUS J. VAN DER VLEUTEN

Applicant(s) herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.

2. [ ] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.

3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S.C. 371 (c)(2))
   a. [X] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).

6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2))

7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.

8. [ ] A translation of the amendment to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).

9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.

12. [X] An assignment document for recording. A separate cover sheet is compliance with 37 C.F.R. 3.28 and 3.31 is included.

13. [X] A FIRST preliminary amendment.
    [X] A SECOND OR SUBSEQUENT preliminary amendment.

14. [ ] A substitute specification.

15. [X] A change of power of attorney and/or address letter.

16. [X] Other items or information:
    a) CITATION OF RELATED CASES;
    b) AUTHORIZATION PURSUANT TO 37 CFR 1.136(a)(3)

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I HEREBY CERTIFY THAT THIS PAPER OR FEE IS BEING DEPOSITED WITH THE UNITED STATES POSTAL SERVICE "EXPRESS MAIL POST OFFICE TO ADDRESSEE" SERVICE UNDER 37 CFR 1.10 ON THE DATE INDICATED ABOVE AND IS ADDRESSED TO THE COMMISSIONER OF PATENTS AND TRADEMARKS, WASHINGTON, D.C. 20231.

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U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/623945	PCT/EP00/00217	PHN 17,285

17 [X] The following fees are submitted:		CALCULATIONS (PTO USE ONLY)
BASIC NATIONAL FEE (37 C.F.R. 1.492(A)(1)-(5)):		
Search Report has been prepared by the EPO or JPO	$940.00	
International preliminary-examination fee paid to USPTO (37 C.F.R. 1.482)	$720.00	
No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2)	$760.00	
Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO	$970.00	
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)	$ 96.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =		$970.00

Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				$	
CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE	
Total Claims	19	- 20 =		X $ 18.00	$
Independent claims	2	- 3 =		X $ 78.00	$
MULTIPLE DEPENDENT CLAIMS (if applicable)				+ $260.00	$
TOTAL OF ABOVE CALCULATIONS =					$970.00
Reductions by 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 C.F.R. 1.9, 1.27, 1.28)					$
SUBTOTAL =					$970.00
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(f)). +					$
TOTAL NATIONAL FEE =					$970.00
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28,3.31). $40.00 per property +					$40.00
TOTAL FEES ENCLOSED =					$1010.00
				Amount to be refunded	$
				charged	$1010.00

a. [ ] A check in the amount $_____ to cover the above fees is enclosed.

b. [X] Please charge my Deposit Account No. 14-1270 in the amount of $1010.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fee, with the exception of the Base Issue Fee, which may be required, or credit any overpayment to Deposit Account No. 14-1270. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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DATE OF MAILING:

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Atty. Docket

Franciscus Kamperman *et. al.* PHN 17,285

Serial No.: Art Unit:

Filed: CONCURRENTLY Examiner:

Title: Embedding Supplemental Data In An Encoded Signal

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

FIRST PRELIMINARY AMENDMENT

Sir:

Prior to calculation of the filing fee and examination, please cancel claims 5-9.

REMARKS

The claims have been amended to delete all multiple dependencies. Entry prior to calculating the filing fee according to MPEP §506, is respectfully solicited.

Respectfully submitted,

By Michael E Belk
Michael E. Belk, Reg. 33,357
Patent Attorney
(914) 333-9643
September 11, 2000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Atty. Docket

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Serial No.: Art Unit:

Filed: CONCURRENTLY Examiner:

Title: Embedding Supplemental Data In An Encoded Signal

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

SECOND PRELIMINARY AMENDMENT

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE CLAIMS

Please amend the claims as follows:

1. (amended) A method of encoding data [(e) by means of auxiliary information (p), characterized in that, for], comprising:

embedding supplemental data [(x),] by inserting the supplemental [information (x) is inserted] data into the data [(e),]; and

deriving the supplemental data [is derived] from other data [(a0(1))].

2. A method of extracting supplemental data of encoded data as defined in claim 1.

3. (amended) A method of encoding input data, comprising the steps of: [by]

partitioning the data into frames; [,]

determining a set of parameters for each frame; [,]

reducing the data rate of the input signal by applying an algorithm which is controlled by the parameter set whereby the encoded data [comprises] includes the set of parameters or at least data which can be used to derive the parameter set and the data rate-reduced signal; [,] and

[characterized in that, for]

embedding supplemental data [(y)] into the encoded signal, the parameter set is affected by the supplemental data [(y)].

4. A method of extracting information which is embedded in the parameter set of an encoded signal as defined in claim 3.

Claims 5-9 have been deleted.

Please add the following new claims:

10. A signal comprising the encoded data of claim 1.

11. A data carrier comprising a recorded signal of claim 10.

12. A signal comprising encoded data of claim 3.

13. A data carrier comprising the recorded signal of claim 12.

14. An arrangement for performing the method of claim 1.

15. An arrangement for performing the method of claim 2.

16. An arrangement for performing the method of claim 3.

17. An arrangement for performing the method of claim 4.

18. A playback device with an arrangement as defined in claim 2.

19. A playback device with an arrangement as defined in claim 4.

20. A playback device with an arrangement as defined in claim 20.

21. The playback device of claim 14, including a Disc player for audio and audio-visual media, respectively.

22. The playback device of claim 15, including a Disc player for audio and audio-visual media.

23. The playback device of claim 16, including a Disc player for audio and audio-visual media.

24. The playback device of claim 17, including a Disc player for audio and audio-visual media.

REMARKS

The added claims replace claims that were deleted in the "First Preliminary Amendment". Entry prior to examination is respectfully solicited.

Respectfully submitted,

By Michael E Belk
Michael E. Belk, Reg. 33,357
Patent Attorney
(914) 333-9643
September 11, 2000

Embedding supplemental data in an encoded signal.

The invention relates to an arrangement for and a method of embedding supplemental data in an encoded signal.

There is a growing need to accommodate supplemental data in encoded data, such as encoded audio and video signals, preferably without increasing the data rate. Especially if the supplemental data is used as watermarks, it should be added in a perceptually invisible manner. Watermarks may comprise information, for example, about the source or copyright status of documents and audio-visual programs. They can be used to provide legal proof of the copyright owner, and allow tracing of piracy and support the protection of intellectual property.

The Super Audio Compact Disc (SACD) format, for example, specifies lossless coding (LLC) to allow about twice as many data effectively on the disc. The lossless coder is required to allow a playing time of up to 74 minutes of multi-channel audio in SACD quality. As the words "lossless coding" point out, the required storage capacity of any data is reduced in such a way that, after decoding, the original signal is reproduced bit-identically. Such an encoder / decoder is described, for instance, in Improved Lossless Coding of 1-Bit Audio Signals, by Fons Bruekers, Werner Oomen, René van der Vleuten, Leon van de Kerkhof, Audio Engineering Society, 103rd Convention 1997, September 26-29, New York, 4563 (I-6). Encoding is performed by partitioning an input data stream into frames and determining a set of optimized parameters for each frame. Part of these parameters issued for prediction to remove redundancies. The difference between the original signal and the prediction signal, which is referred to as residual signal, comprises much less relevant information, if good prediction parameters can be found. As lossless coding is envisaged, the residual signal cannot be omitted, but if it comprises less relevant information, it can be entropy-encoded very efficiently, using some other part of the optimized parameters. As the redundant information is held in the parameter set, the parameter set as well as the entropy-encoded residual signal are stored and needed for lossless decoding.

If supplemental information is needed, for instance for purposes of watermarking, it may be added – as is fairly widely known – by adding it to the original signal in such a way that the signal amendment will not be noticed by a listener. A signal

altered like this can no longer be considered as a (bit true) original signal. Additionally, this kind of watermarking suffers from the fact that it is not possible to detect watermarks present in the encoded signal without lossless decoding. For reasons of simplicity of the watermark decoder, it is desirable to have the option to detect watermarks prior to lossless decoding

It is an object of the invention to provide an arrangement for and a method of embedding supplemental data in an encoded data signal, which allows the embedded supplemental data to be read without decoding the whole signal and does not influence music quality.

To this end, a method according to the invention is characterized in that, for embedding supplemental data, the supplemental information is inserted into the data, and the auxiliary information needed to encode the supplemental data is derived from other data available in the encoding process.

The advantage of the invention is that, by inserting the data into the data to be encoded, the supplemental information cannot be removed without disturbing the content of the encoded signal. As the auxiliary information needed to encode the supplemental information is derived from other data available in the encoding process, the auxiliary information to encode the supplemental data does not need to be recorded or stored for a later decoding process. Thus, this method is very economical with respect to the bit rate.

It is another object of the invention to provide an alternative to the first solution.

To this end, a further method according to the invention is characterized in that, for embedding supplemental data into the encoded signal, the parameter set is affected by the supplemental data. Thus, not all of the complete data has to be decoded to read a watermark, but only the part of the data where the parameters used for encoding/ decoding are contained. As the supplemental information is embedded in the parameter set, no additional bit has to be spent for this information.

The supplemental information may be embedded by choosing an even or odd number of parameters or by changing the least significant bit of e.g. the first parameter. As an example, an even number of parameters represents the value '1' of a watermark bit; an odd number of parameters represents the value '0' of a watermark bit.

The invention benefits from the fact that, for practical reasons (computation power, costs, ...), not the best set of parameters but a reasonably good set of parameters is

determined for encoding. Therefore, these algorithms have been designed to work with a sub-optimal set of parameters as a rule. Small changes in the parameter set, like changing the least significant bit of a parameter, adding a dummy parameter in order to achieve an odd or even number of parameters, whatever is needed to embed a watermark bit or even omit a parameter in order to achieve the odd or even number of parameters, will thus normally have no huge impact on the encoding efficiency. Sometimes, such a small variation of the parameter set may even marginally improve the encoding process.

An advantage of the invention is that, if the data should be kept in lossless coded form, the watermarks cannot be removed without decoding the signal and repeated lossless encoding of the data with an altered set of parameters. As the lossless decoder requires all coefficients, a missing or incorrect coefficient, which has been removed or changed to delete the watermark, will result in a signal loss for the duration of a frame for all channels.

Fig. 1 shows an arrangement for embedding two independent supplemental data x, y into a lossless coded signal. First data x are used to embed watermark information w. As the length of the watermark w is longer than the information that could be stored by the supplemental data, the watermark w is packaged by a package generator 1 to a transport packet, which allows embedding of the bits of the data package like a serial signal. By means of a synchronization pattern included in the header of the transport packet, the beginning of the transport packet can be retrieved easily. The bits x of the transport packet are embedded bit by bit to the lossless coded signal as so-called DST_X_Bits.

Second data y is embedded by so-called DST_Y_Bits. An embedded DST_Y_Bit is set to the value '1' to indicate that the lossless coded signal applies to the up-to-date format. If there is any future need to have a flag, the DST_Y_Bit may be used. It should be obvious to those skilled in the art that the DST_Y_Bit in other recording systems may also be used in the form of a structured data stream to embed information which is longer than a single bit.

In order to encode n parallel data streams, which are referred to as data channels C_0 ... C_{n-1}, the stereo or multi-channel DSD recordings are partitioned into frames. In the embodiment of the invention, seventy-five frames per second are used for each channel C_i. Although the data rate of the watermark signal w depends on the frame rate, the invention is not limited to a special frame rate.

For each frame, a control arrangement, which is not shown as it is not part of the invention, discriminates which mode is used for coding: LLC Plain mode or LLC Coded mode. The LLC Plain mode is used in exceptional cases if the compression ratio of a frame is insufficient, and actually contains plain DSD.

The chosen LLC algorithm is based on a prediction filter and a probability table. To optimize the compression ratio of the LLC Coded mode, a parameter control unit 4 analyzes each channel separately every frame again. The parameter control unit 4 calculates, for each channel C_i, a set of prediction filter coefficients $A_i = a_i(1) \ldots a_i(k_i)$ for each prediction filter and a set of probability table coefficients $\Pi_i = \pi_i(1) \ldots \pi_i(m_i)$ for each probability table. In the embodiment of the invention, the length of a prediction filter coefficient a_i is nine bits, whereas the number k_i of prediction filter coefficients is variable, but is limited to a maximum value of 128. Each probability table coefficient π_i has a length of seven bits. The number m_i of the probability table coefficients π_i is also variable, but is limited by a maximum value of sixty-four. Typically, it is between thirty-two and sixty-four. These numbers are given as examples and represent the numbers which have been found to give the best results for audio signals, but should not be interpreted as limiting the invention to these numbers. The numbers of course depend on the frame rate, the prediction filter algorithm and the content of the source signal. However, other numbers allowing a better compression ratio might be found.

Determining optimal coefficients a, π is difficult and requires considerable computing power. Therefore, a compromise is made to select just a reasonably good set of coefficients. As a separate coefficient set A_i, Π_i s calculated for each channel C_i, the coefficient sets used for each channel will differ from each other, but do not need to differ in every case.

To insert a DST_Y_Bit into a frame, a flag generator 3 alters the least significant bit LSB of the first filter coefficient $a_0(1)$. As already mentioned before, no substantial decrease in encoding performance should be realized by slightly altering the filter coefficients.

All coefficients of the sets A and Π, including the modified coefficient $a_0(1)$, are substantial for the encoded signal and must thus be recorded for a later reading or decoding process. As all coefficient sets A as well as Π still have some redundancy, a first and a second compressor 5, 6 are used to generate compressed data words A' , Π'. Preferably, a compression algorithm is used, which will allow the corresponding

decompression of A' and Π' in a most easy way, so that reading the embedded DST_Y_Bit could be done without great effort.

It is important that the coefficients, the values of which have been modified, are also used for the lossless encoding instead of the original evaluated coefficients. Otherwise, the decoding process will fail. In this embodiment of the invention, the function of the lossless encoder is split up into an encoding prediction unit 7 for each channel C_i and an arithmetic encoder 9 which is common to all encoding prediction units 7. The structure of an encoding prediction unit 7 is shown in Figure 2.

An encoding prediction unit 7 comprises a prediction filter 71 which is initialized with the corresponding filter parameter set A_i. By means of a level converter 72, a binary '0' of the input signal x_i is converted into the numerical value '-1' and a binary value '1' is converted into the numerical value '+1' prior to inputting the input signal to the prediction filter 71. The output signal of the prediction filter 71 is quantized by a first and a second quantizer 73, 74. The output signal of the first quantizer 73 is ex-ored with the input signal x_i by means of an EXOR gate 75 and forms the residual signal e_i, which is the first of two output signals of the encoding prediction unit 7. The output signal of the second quantizer 74 serves as an index α_i for a probability table stored in an array 76. The probability table consists of the probability parameter set Π_i. The output signal of the array 76 forms the second output signal of the encoding prediction unit 7, the probability signal p_i. The usage of the probability table is described in greater detail in the paper cited in the opening paragraph.

A multiplexer 8 merges the residual signals $e_0 \ldots e_{n-1}$ into e and the probability signals $p_0 \ldots p_{n-1}$ into p. The output of the watermark generator 2 is also fed to one input of the multiplexer 8. To embed the DST_X_Bits of the watermark information, the multiplexer 8 inserts the DST_X_Bit in front of e. Due to the design of the arithmetic coder 9, a probability coefficient to code the DST_X_Bit, hereinafter referred to as the watermark probability coefficient p_w, is indispensable. To save storage space in the embodiment of the invention, the watermark probability coefficient p_w is derived from the first prediction filter coefficient $a_0(1)$. To this end, the first prediction filter coefficient $a_0(1)$ of the first channel is fed to a watermark probability module 10. By means of this module, the first seven bits of the coefficient $a_0(1)$are interpreted in reverse order as an unsigned integral number D to which the value 1 is added. By using a derived value for the watermark probability coefficient, a recording of the watermark probability coefficient is not necessary and requires no

supplemental bit in the encoded data block. In this way, embedding the DST_X_Bit will lengthen the coded LLC block only marginally.

The arithmetic coder 9 generates the Coded DSD signal from the signal e and the probability signal p.

As the DST_X_Bit is inserted as the first bit of each block to be coded by the arithmetic coder 9, the DST_X_Bit may not be located as a single bit in the Coded DSD signal. Therefore, it cannot be removed without decoding the Coded DSD signal. Deleting or changing one or some bits will inevitably cause a loss of data of the whole frame. On the other hand, a rudimentary arithmetic decoder is sufficient for reading a watermark. Hence it meets the ideal of a watermark in a perfect manner: difficult to remove but easy to read. However, it is not mandatory to insert the DST_X_Bit in front of the signal e, but it will slightly simplify the decoding process of the watermark, as only the beginning of the Coded DSD signal has to be evaluated.

The following table shows the rough syntax of a frame coded in the LLC Coded Mode:

LLC bit	CNTRL	A'	Π'	CODED DSD

In this case, the bit LLC has the value '1' to indicate an LLC Coded mode data block. The bits of the CNTRL sub-block contain some control information such as, for example, the number k_i of prediction filter coefficients and the number m_i of probability coefficients of a given channel Ch_i. The next two sub blocks A' and Π' contain the sets of the prediction filter coefficients A and the probability coefficients Π in compressed form. The last block CODED DSD finally contains the coded DSD signal. As explained hereinbefore, the length of the data blocks A, P and CODED DSD varies from frame to frame.

The LLC Coded data blocks are written onto a data carrier such as, for example, a SACD or a DVD. As the process of writing onto the data carrier and the process of reading from the data carrier are not part of the invention, but a lot of appropriate means are known to those skilled in the art, this is not described herein but symbolized by the dashed line 11 and referred to as disk interface.

In the reading device, here in the embodiment of the invention, for example, a SACD or a DVD disc player, a data block is detected as being an LLC Coded block if the first bit, the LLC-Bit, has the value '1'. In this case, the data block is divided into its sub-blocks A', Π' and CODED DSD by means of the data contained in the control data block

CNTRL. The sub blocks A' and Π' are decompressed by a first and a second decompressor 12, 13 to regain the coefficient sets A_i, Π_i. For each channel a separate decoding prediction unit 14 is provided, each decoding prediction unit 14 comprising a prediction filter and a probability table. At the beginning of decoding an LLC encoded block, the coefficient sets A_i, Π_i are loaded to the appropriate prediction filters and probability tables of the decoding prediction units 14.

The decoding prediction units 14 also reconstruct the probability signals $p_0 \ldots p_{n-1}$, which are combined to the signal p by a multiplexer 15 of the reading device. The signal p is fed to an arithmetic decoder 16 which, by means of the probability signal p, decompresses the data contained in the sub-block CODED DSD to a data stream e. By means of a demultiplexer 17, the data stream e is split into the different residual signals $e_0 \ldots e_{n-1}$ of the individual channels and fed to the decoding prediction units 14.

The structure of a decoding prediction unit 14 is shown in Figure 3. The residual signal e_i of each channel is fed to a first input of an EXOR gate of the decoding sub-unit. The output of the EXOR gate forms the output signal of each channel Ch_i. The output signal is also fed to a level converter, which performs the same operation as the level converter in the recording device described hereinbefore. The output of the level converter is fed to the prediction filter. The output of the filter is fed to two quantizers. The output of the first quantizer is connected with the second input of the EXOR gate, the other output of the quantizer is used as an index α_i for the probability table stored in an array. The values p_i of all that is selected by the index α_i are fed via the multiplexer to the arithmetic decoder.

A flag detector 18 is used to reconstruct the embedded DST_Y_Bits. As the DST_Y_Bit is stored in the first coefficient, only the beginning of the compressed A' block has to be examined by the flag detector 18. The flag detector 18 decompresses only the beginning of the A' block and picks out the first filter coefficients $a_0(1)$ of the first channel and analyzes its least significant bits to decide the value of the DST_Y_Bit. As the compressing algorithm for the A and Π blocks was chosen to allow easy decompression, the watermark detector may be designed very primitively as compared to the total decoder.

To extract the watermark w, the coefficient $a_0(1)$ determined by the watermark flag detector 18 is fed to a watermark probability module 19 of the reading device. The watermark probability module calculates, as described for the recording device, the watermark probability coefficient p_w. The watermark probability coefficient p_w is fed to the arithmetic decoder to decode the DST_X_Bit. As the DST_X_Bit is the first bit outputted by the arithmetic decoder, it can easily be extracted by a watermark detector 20. However, with

a more sophisticated detector, it may be extracted anywhere from the signal, wherever it has been decided to insert it. A formatter 21 extracts the watermark information w from the DST_X_Bits, which are reconverted from a serial bit stream to a data block with the help of the synchronization pattern.

Although the watermark detection function may be integrated in the other decoding means of the reading device, this structure shows that a watermark detection may be done in a stand-alone situation. There is no need to decode the whole coded DSD signal. Therefore, the watermark flag detector 18, the watermark probability module 19, the watermark detector 20 and the formatter 21 may also be integrated in a device of its own and run without the more complicated functions incorporated in the decoding prediction units 14.

The LLC Coded mode has hitherto been described. As described above, if sometimes encoding fails to reduce the bit rate, the signal can just be stored as plain DSD. This data mode is referred to as LLC Plain mode and shown below:

LLC Bit	DTS_X_Bit	Plain DSD

The LLC bit is set to the value of '0' to indicate that the frame contains Plain DSD. The bit following the LLC Bit is used to store the DTS_X_Bit of the watermark in plain format. The DTS_X_Bit is followed by the Plain DSD data. This ensures that every coded block contains a DTS_X_Bit, regardless of whether it is a Coded DSD or a Plain DSD block. This has the advantage that the serial data stream of the DST_X_Bits does not depend on the format that is used. On the other hand, it is true that the plain DTS_X_bit of a Plain DSD may be changed without doing any harm to the signal content of a block in Plain DSD. However, as a Plain DSD block is the exception in the great majority, there will be more than enough uninterrupted Coded DSD blocks to carry the watermark in full length.

In a further embodiment of the invention, more than one supplemental bit is embedded into the lossless coded signal by changing more than one LSB of the parameters. To embed two bits per frame, for instance, the first and the second prediction filter coefficient $a_1(0)$, $a_2(0)$ of the first audio channel are unused. These two bits may be used to represent the following information:

LSB $a_0(1)$	LSB $a_0(2)$	Meaning
0	0	Watermark bit '0'
0	1	Watermark bit '1'
1	0	Synchronization symbol
1	1	Reserved for future use

As only one watermark bit is provided for use in each frame, the watermark information has to be written in a serial data format. Therefore, the synchronization symbol '10' serves to detect the beginning of the watermark information.

CLAIMS:

1. A method of encoding data (e) by means of auxiliary information (p), characterized in that,
for embedding supplemental data (x), the supplemental information (x) is inserted into the data (e), and the auxiliary information (p_w) needed to encode the supplemental data is derived from other data ($a_0(1)$).

2. A method of extracting supplemental data of encoded data as defined in claim 1.

3. A method of encoding input data by partitioning the data into frames, determining a set of parameters for each frame, reducing the data rate of the input signal by applying an algorithm which is controlled by the parameter set whereby the encoded data comprises the set of parameters or at least data which can be used to derive the parameter set and the data rate-reduced signal,
characterized in that,
for embedding supplemental data (y) into the encoded signal, the parameter set is affected by the supplemental data (y).

4. A method of extracting information which is embedded in the parameter set of an encoded signal as defined in claim 3.

5. A signal comprising encoded data as claimed in claim 1 or 3.

6. A data carrier with a recorded signal as claimed in claim 5.

7. An arrangement for performing a method as claimed in claim 1, 2, 3 or 4.

8. A playback device with an arrangement as defined in claim 2 and/or 4.

9. A playback device as claimed in claim 7, characterized that it is a Disc player for audio and audio-visual media, respectively.

ABSTRACT:

There are two different methods of embedding supplemental data, e.g. for watermarking into an encoded signal.

I. For an encoder, which needs auxiliary information for encoding (=probability information in this special case), the auxiliary information to encode the supplemental data is derived from data used otherwise in the encoding process. The advantage is that the derived auxiliary data does not have to be stored, so that embedding the supplemental data is economical with respect to the total amount of bits used.

II. In the encoding process used for super Audio CD, a set of parameters (e.g. filter coefficients) is used by the encoder, whereby these parameters have to be stored, as they are needed for decoding. To embed supplemental data, at least one of the chosen parameters (e.g. the LSB of the first coefficient) is set to a dedicated value in response to the value of the supplemental data to be embedded. The advantage is that the bit rate will not be affected at all.

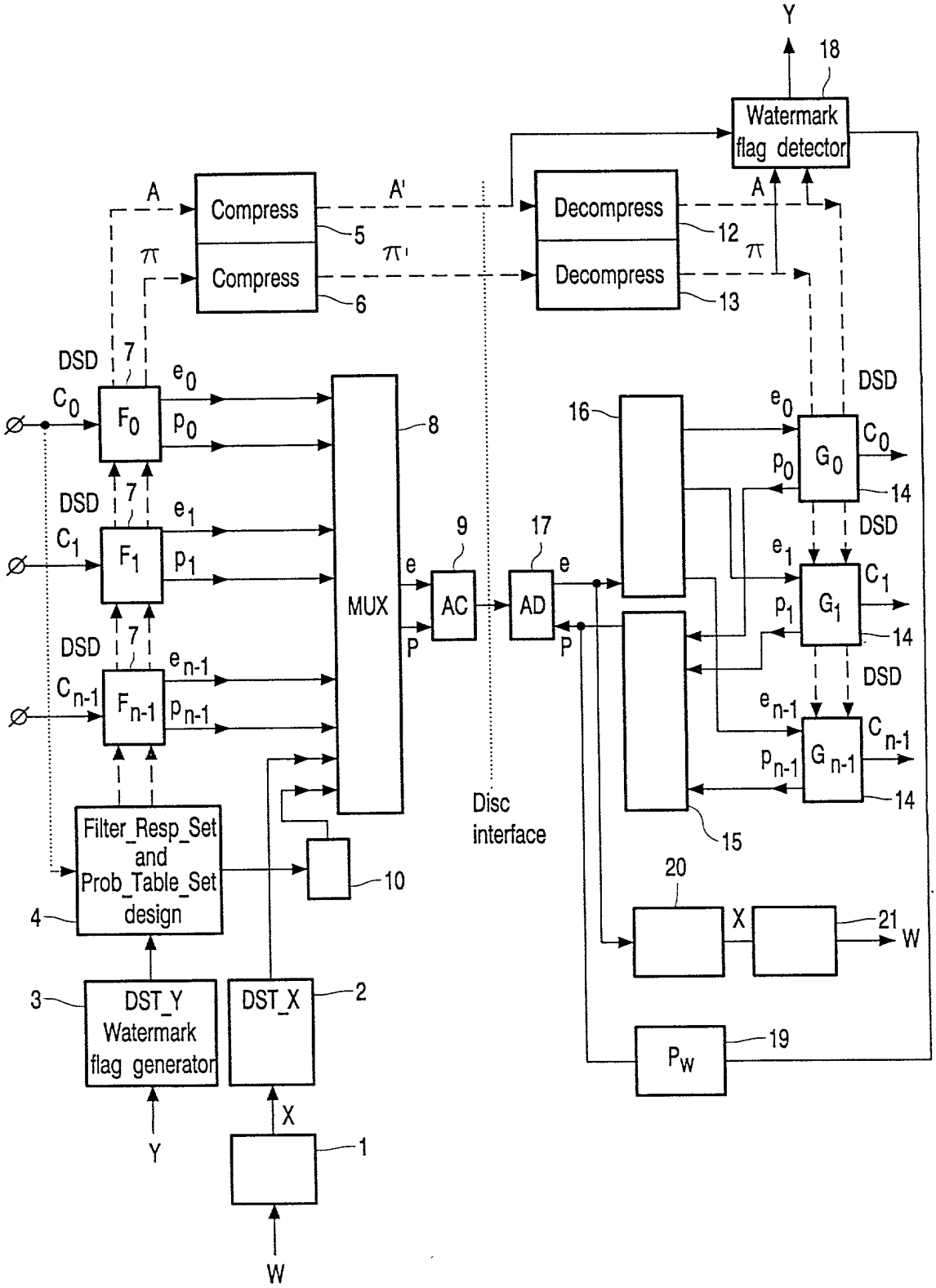
Y
18
Watermark flag detector
A
A'
Compress
5
Compress
6
π
π'
Decompress
12
Decompress
13
A
π
DSD
7
C_0
F_0
e_0
p_0
C_1
F_1
e_1
p_1
C_{n-1}
F_{n-1}
e_{n-1}
p_{n-1}
MUX
8
e
P
9
AC
AD
17
16
15
G_0
G_1
G_{n-1}
14
20
X
21
W
P_w
19
Disc interface
Filter_Resp_Set and Prob_Table_Set design
4
10
3
DST_Y Watermark flag generator
DST_X
2
Y
X
1
W

FIG. 1

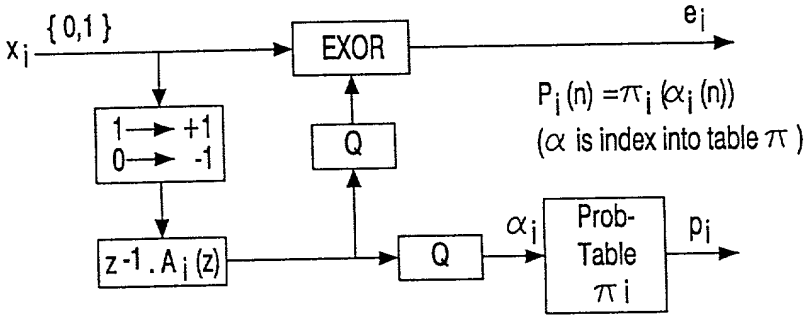
x_i
{0,1}
EXOR
e_i
$P_i(n) = \pi_i(\alpha_i(n))$
(α is index into table π)
1 → +1
0 → -1
Q
$z^{-1} . A_i(z)$
Q
α_i
Prob-Table πi
p_i

FIG. 2

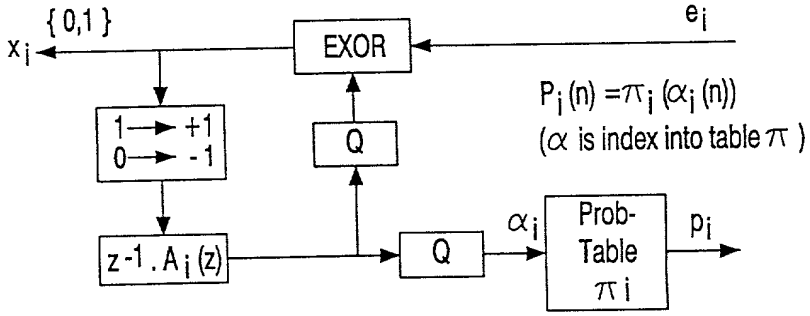
x_i
{0,1}
EXOR
e_i
$P_i(n) = \pi_i(\alpha_i(n))$
(α is index into table π)
1 → +1
0 → -1
Q
$z^{-1} . A_i(z)$
Q
α_i
Prob-Table πi
p_i

FIG. 3

Combined Declaration For Patent Application and Power of Attorney (Continued) (includes Reference to PCT International Applications)	Attorneys Docket Number **PHN 17.285 US**

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) abnd/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 if Title 18 of the United states Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE August 2, 2000	DATE August 2, 2000	DATE August 2, 2000
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE

09/623945

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER PHN 17.285 US

As a below named inventor, I hereby declare that: 533 Rec'd PCT/PTO 12 SEP 2000

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"Embedding supplemental data in an encoded signal"

the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No.

on

and was amended

on

☒ was filed as PCT international application

Number PCT/EP00/00217

on 10 January 2000

and was amended under PCT Article 19

on (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY	APPLICATION NUMBER	DATE OF FILING DAY, MONTH, YEAR	PRIORITY CLAIMED UNDER 35 USC 119
Europe	**99100580.2**	**13 January 1999**	**YES**